# Wharf T&T Limited

## Report on BWA Technology Trial Test

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## Executive Summary

A broadband wireless access (BWA) technology trial test was conducted in September 2008 to evaluate the broadband wireless access coverage performance, functionalities and potential applications. The equipment was provided by a leading telecommunication equipment vendor and was based on WiMAX standard IEEE 802.16e.

In the trial, out-door and in-door FTP throughput test were performed near the road and around the shopping malls in Kwun Tong District in Hong Kong.

The following items were tested in the trial.

- Radio link performance in out-door and in-door
- Network performance including throughput and latency
- VoIP application

The result of the trial showed that the BWA radio signal reception was good for Line Of Sight (LOS) with throughput of 1.2 Mbps demonstrated. The VoIP over BWA radio link showed acceptable voice quality.

**Summary of Trial Test Setup and Test Results:**

| **Test Setup** | **Results** | **Remark** |
|---|---|---|
| Coverage | √ | Out-door and In-door |
| Frequency Band | √ | BTS Centre Frequency = 2.5225 GHz |
| Channel Bandwidth | √ | 2.5 MHz |
| **Radio Link Performance Test** | **Results** | **Remark** |
| RF Power | √ | Subject to OFTA's Temporary Permit for this Trial Test |
| RSSI Power – Out-door LOS | √ | |
| RSSI Power – In-door NLOS | √ | |
| **Network Performance Test** | **Results** | **Remark** |
| Throughput | ~1.2Mbps | Out-door LOS measurement |
| Jitter | √ | Out-door and In-door measurement |
| **Service Applications Test** | **Results** | **Remark** |
| Fixed line VoIP Service | √ | Subjective test |

## 1. Test Objective

The purpose of the broadband wireless access (BWA) technology trial was to test the broadband wireless access link performance, functionalities and potential applications. The BWA equipment under trial was provided by a leading telecommunication equipment vendor and it was based on WiMAX standard IEEE 802.16e.

## 2. Test Schedule

The technology trial was conducted in September to October 2008.

## 3. Test Equipment

The BWA system under trial consisted of two functional units: base station and subscriber unit. The technical information of the BWA system is shown below.

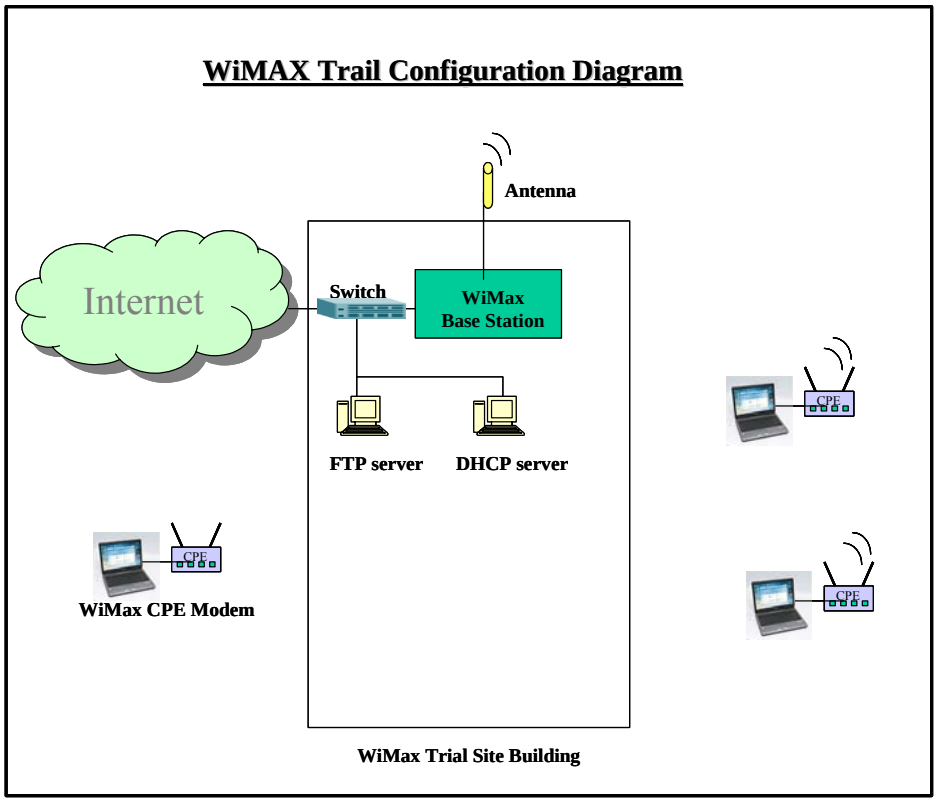
| | |
|---|---|
| Centre Frequency: | 2.5225 GHz |
| Channel Bandwidth: | 2.5 MHz |
| Access Scheme: | Orthogonal Frequency Division Multiple Access (OFDMA) |
| Duplexing Scheme: | Time Division Duplexing (TDD) |
| Baseband Modulation: | QPSK/16QAM/64QAM adaptive |
| Base Station Components: | Base Station<br>Outdoor Antenna<br>Base Station Timing System<br>GPS Antenna |
| Subscriber Unit Components: | CPE Indoor Unit (with integral antenna) |

## 4. Test Sites

The trial site was selected in Kwun Tong area with the target coverage to the near-by area. Base station was installed inside World Tech Centre with its outdoor antenna installed on the rooftop. Subscriber unit was tested at various out-door and in-door locations.

## 5. Test Configuration

The figure below shows the main configuration of the technology trial.




# 6. Test Items and Results

## 6.1. Radio Link Performance

### 6.1.1. Outdoor Coverage, Signal Level and Throughput Test

Two types of outdoor coverage measurement were conducted in the trial.

a. First, by drive-test inside an automobile to measure signal level strength and throughput in the vicinity of coverage area.
b. By walk-test to measurement signal level at street level and back street alley between buildings in the coverage area.

*Nominal Measurement Result*

| Physical Environment | Preamble RSSI | Band RSSI | Band CINR | Moduation FEC | CPE Tx Power | DL Rate (Kbps) | UL Rate (Kbps) |
|---|---|---|---|---|---|---|---|
| Drive Test - Inside Vehicle | -70 | -77 | 21 | QAM16 3/4 | -26dBm per SC | 1.2Mbps | 1.1Mbps |
| Walk Test - Street level | -72 | -80 | 14 | QAM16 3/4 | -6dBm per SC | 1.2Mbps | 1.1Mbps |

*Observation*

The outdoor drive-test and walk-test receive signal level measurement was coherent to RF simulation using digital map method. Average Preamble RSSI signal level was –72 dBm.

The measurement spots were generally NLOS, signal was multi-path reflection from surrounding buildings. Signal strength level was acceptable for data transfer at expected rate near 1.5/0.9Mbps.

However, the signal strength was significant weaken in narrow back-street alley surrounded by buildings where reflection signal was limited. Preamble RSSI signal level was below -80dBm. Circuit was unstable and barely able to maintain connectivity at a very low data transfer rate, e.g. 200kbps.

### *6.1.2. Indoor Coverage, Signal Level and Throughput Test*

In-door signal reception at next-to-window (within 3-5 meters) was generally acceptable and strength level was similar to open street condition.

The trial FTP throughput test measurement was near to the expected value

- In-door next-to-window locations
  - DL/UL bandwidth 1.2/1.1Mbps (RSSI 60~78 dBm)

*Nominal Measurement Result*

| Physical Environment | Preamble RSSI | Band RSSI | Band CINR | Moduation FEC | CPE Tx Power | DL Rate (Kbps) | UL Rate (Kbps) |
|---|---|---|---|---|---|---|---|
| Indoor Test - next-to-window | -78 | -80 | 19 | QAM 16 3/4 | -9 dBm per SC | 1.2Mbps | 1.1Mbps |
| Indoor Test - inner floor | -91 | -95 | 6 | QPSK CC 1/2 | 6 dBm per SC | 400kbps | 1.2Mbps |

*Observation*

Signal reception at inner building floor was significantly attenuated by the interior structure. For example, inside a shopping center, signal was significant reduced to around –90dBm even a FTP data transfer cannot be initiated.

## *6.2. Network Performance - Latency*

Two types of latency measurement were conducted in the trial.

a. First, by drive-test inside an automobile to measure latency in the vicinity of coverage area.
b. By walk-test to measurement latency at indoor coverage area.

*Nominal Measurement Result*

| Physical Environment | Preamble RSSI | Band RSSI | Band CINR | Moduation FEC | CPE Tx Power | Latency in ms (Min) | Latency in ms (Max) | Latency in ms (Av.) |
|---|---|---|---|---|---|---|---|---|
| Drive Test-Inside Vehicle | -70 | -77 | 21 | QAM16 3/4 | -26 dBm / SC | 52 | 86 | 65 |
| Indoor Test-next-to-window | -78 | -80 | 19 | QAM16 3/4 | -9 dBm / SC | 61 | 101 | 103 |
| Indoor Test-Inner Floor | -91 | -95 | 6 | QPSK CC 1/2 | 6 dBm / SC | 87 | 198 | 107 |

### 6.3. WiMax CPE modem Plug and Play

The modem installation process was simple Plug and Play. The trial CPE modem could automatically register into the WiMax network on power-up.

*Test Result and Observation*

The CPE modem can obtain an IP address from the network to complete the setup process. Invalid CPE could not register into the network.

### 6.4. VoIP Application

VoIP voice call was made and running on the BWA radio link in this trial.

*Test Result and Observation*
Voice quality for calls through BWA radio link was acceptable.

## 7. Conclusion

Coverage by out-door base-station was environmental sensitive, highly dependent on landscape and blockage and reflection of civil objects. Although the trial demonstrated NLOS characteristics of WiMax, it also showed that prediction of signal strength at particular spot was highly sophisticated and merely the geographical proximity to the base-station was far less than a sufficient factor. Indoor penetration loss was found significant. Deep building penetration from outdoor base-station was not practical in general and can only be assumed in next to window position.

In areas with reasonable signal reception, close to target bandwidth and performance figures can generally be achieved. Severely blocked outdoor location and indoor inner floor area were be difficult for RF signal to penetrate for achieving acceptable coverage.

In the trial test, it was also demonstrated that RF simulation result using digital map was showing consistent approximation with the on-site measurement for outdoor and next-to-window locations.